AN INVESTIGATION OF THE POSSIBILITY OF DIFFERENTIAL EFFECTS OF COLOR UPON HUMAN EMOTIONS

by

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POPULAR TREATMENTS OF COLOR AND EMOTION

"Color affects our emotional attitudes and our behavior even when we are not aware of it."[1] This statement from the pamphlet, Color Planning for School Interiors, exemplifies the viewpoint of the popular books and articles which have been written about the uses of color in such areas as advertising, merchandising, education, hospital administration, and home decoration.

In the popular literature, certain emotional values are consistently attributed to each color: orange and red are supposed to be stimulating and exciting; yellow is warm, vibrant, and cheerful; blue is subduing, depressing, and soothing; green, neither stimulating nor sedative, is tranquil and peaceful; violet and purple are cold, exotic, subduing, and depressing; blue-green is cool and soothing; and magenta is exotic and pleasing. Red, yellow, and orange are supposed to make one energetic and active; blue and green to make one meditative and listless.[2,3,4]

In addition to these general effects, certain specific, physiological changes supposedly arise when one perceives color. Thus, bright and warm colors are said to stimulate the nervous system. Red and bright illumination are alleged to increase tension. Blue raises the blood pressure by

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[1] M. Pleason, Ed., Color Planning for School Interiors, p. 23.

[2] A. G. Abbott, The Color of Life, pp. 130-132.

[3] Faber Birren, Selling Color to People, p. 147.

[4] Louis Cheskin, Color-Tuning Your Home, pp. 8-9.

contracting the arteries. Also, blue slows pulse rate, and orange and red increase it. Red aggravates any inflammatory condition, and green affects the nervous system.[5,6,7] An explanation offered is that

> " 'The emotional excitements which are recognized through changes in blood pressure, pulse-frequency and rhythm are brought forth through association.' Green may recall nature, mountains, lakes. Red may recall the sunset, the fireplace. 'These superficial associations lead to deeper lying memories, which explain the affective emphasis of the attitudes toward colors.' "[8]

Also emphasized is the importance of "subjective" impressions. Seen "objectively", green is fresh, clear, and pleasing. "But green illumination shining on the human flesh causes a subjective viewpoint that instantly makes the color repulsive."[9]

According to Birren,[10] judgments of time, physical length, and weight are affected by different colors. Under the influence of red light, for example, time may be overestimated, and objects may seem longer and heavier.

Birren[11,12] also states that colors are associated with sounds, odors, forms, and cutaneous experiences. For example, slow music is blue; and orange is a rectangle, while blue is a circle or sphere. The relationship between color and thermal experience has received much attention. Red,

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[5]Abbott, op. cit., p. 132.

[6]Birren, op. cit., pp. 191-192.

[7]Faber Birren, Functional Color, pp. 98-100.

[8]Faber Birren, Color Psychology and Color Therapy, p. 156.

[9]Ibid., p. 142.

[10]Ibid., pp. 146-147.

[11]Ibid., p. 162-173.

[12]Birren, Selling Color to People, pp. 138-145.

yellow, and orange are considered warm colors, and blue, green, and purple are considered cool colors. There are two explanations offered for these thermal effects, one emphasizing psychological factors; the other, physical. Stressing the psychological aspect, for instance, Pleason states:

> "The characterization of colors as warm or cool is primarily an expression of our feelings about them. And the feelings correspond to reality. Colors in which red, orange, and yellow predominate are associated in our memories with fire and bright sunlight. Blues are typically associated in our memories with such things as expanses of cool water, ice, far away hills and horizons, and distant skies."[13]

According to Cheskin, however, colors are physically as well as psychologically cool or warm, some colors being said to reflect or absorb more light than others.[14]

Some persons believe that these primary emotional effects of colors have resulted in symbolism. In Sargent's words:

> "Partly because of its direct emotional effect on us and partly because of its association with various experiences, each color has acquired a symbolism or mystic significance."[15]

These various experiences cover many centuries of history, religion, tradition, and superstition.[16] In the Roman Catholic church, red signifies charity and generosity; in the American Universities, red represents theology; and in heraldy, red means courage and zeal. Red is also the ardent and passionate color. A person paints the town red, and there are red-letter days.[17]

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[13] Pleason, op. cit., p. 39.

[14] Cheskin, op. cit., p. 13.

[15] Walter Sargent, The Enjoyment and Use of Color, p. 50.

[16] Birren, Color Psychology and Color Therapy, p. 172.

[17] Ibid., pp. 169-172.

According to Birren,[18] different types of people prefer different colors. Introverts and conservatives like blue; intellectuals like yellow; the artistic and sophisticated like purple; and the well-balanced like green. The mentally ill are quite sensitive to color. The manic prefers red; the hysteric, green; the schizophrenic, blue; and the paranoid, brown.

Birren explains that preferences for colors are based on specific natural laws and physical reactions and on factors such as class, nationality, race, and religion. An example of the first factor is that white may be worn in summer for physical coolness. An example of the second factor is that the same color may signify different things in different countries.[19] It is also said that the area a color occupies, the object with which it is associated, and the presence of other colors, all affect the preference for colors.[20]

Although all the authors attribute nearly identical emotional effects to various colors and consider these effects universal, they give no good evidence on which to base these speculations. Not one of them explains how the emotional effects of colors were ascertained.

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[18]Birren, Selling Color to People, p. 165.

[19]Birren, Functional Color, p. 96.

[20]Louis Cheskin, Color for Profit, pp. 52-55.

II. PSYCHOLOGICAL RESEARCH ON COLOR AND EMOTION

The conclusions drawn in psychological research are not in agreement with the dogmatic statements made in the popular literature. In fact, very little research has been done concerning the emotional effects of colors. Most of the research concerning color has been in the area of the emotional responses of "like" or "dislike", which is to say, in the area of color preferences.

A number of studies have been done on the color preferences of members of different races and cultures. There seems to be fairly general agreement on color preferences among white Americans. Lovett and Schneider[21] found the preference of both normal and psychologically disturbed persons to follow the descending order of: blue, red, green, orange, yellow, purple, black, and white. St. George[22] found that the favorite color of five hundred college students was blue, followed by green, red, yellow, orange, violet, and white.

In a study of Chinese college freshmen and Middle School students, Chou and Chen[23] found the decreasing order of preference to be: white, blue, red, yellow, green, black, orange, violet, and gray. Garth,

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[21] J. W. Lovett and R. A. Schneider, "Studies on the Physiology of Awareness: The Differential Influence of Color on Capillary Blood-Oxygen Saturation." Journal of Clinical Psychology, XI (1955), 366-370.

[22] M. W. St. George, "Color Preferences of College Students with Reference to Chromatic Pull, Learning, and Association." American Journal of Psychology, LI (1938), 714-716.

[23] S. K. Chou and H. P. Chen, "General versus Specific Color Preferences of Chinese Students." Journal of Social Psychology, VI (1935), 290-314.

Moses, and Anthony[24] found the choice of East Indian children and young adults to be: red, green, blue, violet, orange, yellow, and white. Since young Indians and young Americans are more similar than the older members of both races, Garth concluded that education and experience seemed to produce great changes in preferences. Garth and Collado[25] found that Filopino children prefer red, followed by green, blue, violet, orange, white, and yellow. In a study of Mexican children living in Texas, Gesche[26] found the sequence of: red, green, blue, violet, orange, white, and yellow. He also found that education decreased the preference for red, green, and yellow, and increased the preference for blue. Mercer[27] found the order of color choice of American Negroes to be: blue, orange, green and violet, red, yellow, and white. In a study of white and Negro children from similar environments in New York, Hurlock[28] found high agreement between the races.

According to Holden and Basse,[29] white American babies are partial to red, orange, and yellow during the first three years. After the

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[24]T. R. Garth, M. R. Moses, and C. N. Anthony, "Color Preferences of East Indians." American Journal of Psychology, LI (1938), 709-713.

[25]T. R. Garth and I. R. Collado, "The Color Preferences of Filopino Children." Journal of Comparative Psychology, IX (1929), 397-404.

[26]I. Gesche, "The Color Preferences of 1,152 Mexican Children." Journal of Comparative Psychology, VII (1927), 297-311.

[27]F. M. Mercer, "Color Preferences of 1,006 Negroes." Journal of Comparative Psychology, V (1925), 109-146.

[28]E. B. Hurlock, "Color Preferences of White and Negro Children." Journal of Comparative Psychology, VII (1927), 389-404.

[29]R. Staples, "Color Vision and Color Preferences in Infancy and Childhood." Psychological Bulletin, XXVIII (1931), 297-308.

first three years, the order of preference is: blue, violet, red, green, yellow, and orange. In a study of color choice in a group of subnormals, Stacey and Reynolds[30] found males from eight to twelve years old prefer orange; thirteen to fifteen, red; and sixteen to eighteen, blue. Females eight to twelve years of age prefer red; thirteen to fifteen, red; and sixteen to eighteen, blue. In a study of four psychiatric groups (anxiety neurotics, catatonics, manics, and depressives) by Warner,[31] the only significant correlation of certain color choices with disturbed emotional patterns was the preference for green over yellow by the anxiety neurotics. This conclusion seems to contradict Birren's statement that the mentally ill are differentially sensitive to color.

As has been indicated above several times, some people feel that one's environment affects color preference. The fairly general, though not completely consistent, cross-cultural and cross-racial agreement on the sequence of color preference has led to an unresolved controversy between those who favor a nativistic account of color tastes and those who favor an empiricistic account.

On the environmentalistic side, Ellis[32] feels there is great value in studying anthropology and history. Although yellow was well liked in classical Greece and in the present day Orient, it is now disliked in Western cultures. The reason, according to Ellis, seems to be that the

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[30] C. L. Stacey and W. F. Reynolds, "The Color Preferences of a Group of Subnormals." The Training School Bulletin, L (1953), 59-64.

[31] S. J. Warner, "The Color Preferences of Psychiatric Groups." Psychological Monographs, No. 301 (1949).

[32] H. Ellis, "The Psychology of Yellow." Popular Science Monthly, LXVIII (1906), 456-463.

Roman Catholic church considered yellow a pagan color. According to a study by Staples and Walton,[33] pleasurable experience with a color greatly enhances the positive feeling toward that color, and the feeling is maintained to a significant degree for at least as long as five months.

Supporting the hereditary view, St. George[34] states that although preference partly depends on association of color with affections, certain colors because of native "pull" are most preferred. According to Guilford,[35] since affective values or preferences persist over the years in different persons, there must be, in addition to social conditioning and other environmental factors, deep underlying biological factors helping to determine color preference.

Concerning the apparent warmth of colors, of which so much is said in the popular literature, Tinker[36] found that surface texture had little or no effect on judgment when placing colored pieces of material in rank order according to warmth. According to Lewinski,[37] the judgment by fifty men and women of the warmth of different colored lights shone

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[33] R. Staples and W. E. Walton, "A Study of Pleasurable Experience as a Factor in Color Preference." Journal of Genetic Psychology, XLIII (1933), 217-223.

[34] St. George, American Journal of Psychology, LI, 714-716.

[35] J. P. Guilford, "The Affective Value of Color as a Function of Hue, Tint, and Chroma." Journal of Experimental Psychology, XVII (1934), 342-370.

[36] M. A. Tinker, "Effect of Stimulus-Texture upon Apparent Warmth and Affective Value of Colors." American Journal of Psychology, LI (1938), 532-535.

[37] R. J. Lewinski, "An Investigation of Individual Responses to Chromatic Illumination." Journal of Psychology, VI (1938), 155-160.

on a wall followed a warm-to-cool order of: red, orange, yellow, purple, green, and blue. As would be expected, this sequence, obtained by verbal report, is in agreement with popular opinion. Morgensen and English[38] had subjects compare the warmth of pairs of rheostats wrapped in colored paper, and, unknown to the subjects, kept at constant temperature. The results were divergent enough not to be due to chance, but were not at all consonant with common beliefs as to which colors are warm and which are cool. The warm-to-cool order was: green, blue, orange, yellow, red, and purple. This sequence is almost completely opposite from that popularly accepted. In spite of these significant results, the authors concluded that apparent warmth of colors is not intrinsic enough to modify judgment of tactual warmth. Pierce and Weinland[39] reached similar conclusions after comparing temperature readings in a room flooded with colored light with subjects' introspective judgment of their warmth. No one color was significantly warmer than another.

In the area of color as related to specific emotions, the area with which most of the popular literature is concerned, very little has been established. Three studies have employed the technique of matching colors with verbal descriptions of emotions. Wexner[40] asked ninety-four subjects in a general psychology course to match eight colors with eleven mood-tones. Certain colors were chosen to go with certain

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[38] M. F. Morgensen and H. B. English, "The Apparent Warmth of Colors." American Journal of Psychology, XXXVII (1926), 427-428.

[39] D. H. Pierce and J. D. Weinland, "The Effect of Color on Workmen." Personnel Journal, XIII (1934), 34-38.

[40] Lois B. Wexner, "The Degree to Which Colors (Hues) Are Associated with Mood-Tones." The Journal of Applied Psychology, XXXVIII (1954), 432-435.

mood-tones significantly more than other colors: exciting-stimulating (red); secure-comfortable (blue); distressed-disturbed-upset (orange); tender-soothing (blue); protective-defending (red, brown, blue, black, purple); despondent-dejected-unhappy-melancholy (black, brown); calm-peaceful-serene (blue, green); cheerful-jovial-joyful (yellow); dignified-stately (purple); defiant-contrary-hostile (red, orange, black); powerful-strong-masterful (black). In a similar but less comprehensive study, Henner's[41] subjects matched adjectives with abstract pictures painted red or blue. "Happy" and "exciting" were matched with red, and "serene," "sad," and "dignified" were matched with blue. According to Lewinski,[42] fifty men and women ranged six colors on a sequence from most stimulating to most depressing in the following order: orange, red, yellow, green, blue, and purple. All of these results are in agreement with popular opinion. Since the subjects merely matched colors with verbal descriptions of emotions, however, this agreement is to be expected.

In order to measure work output in the presence of different colors, Pressey[43] asked his subjects to perform such tests as tapping, multiplication, continuous reaction, and memory for nonsense syllables on a table flooded with colored light. Although output decreased as brightness of the light decreased, there was no effect of hue alone on

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[41] K. Henner, "Experimental Studies of the Affective Value of Colors and Lines." Journal of Applied Psychology, XIX (1935), 385-398.

[42] Lewinski, Journal of Psychology, VI, 155-160.

[43] S. L. Pressey, "The Influence of Color upon Mental and Motor Efficiency." American Journal of Psychology, XXXII (1921), 326-356.

the functions tested. Pierce and Weinland[44] measured both introspective feelings and work output on a Bogardus factory test machine, in a white workroom flooded with colored light. As the color deviated from white, the subjects' output fell off. This result is evidently not in agreement with that of Pressey. Although pronounced feeling-reactions, such as monotony, euphoria, impatience, excitement, and dizziness were reported, there was no response characteristic of any one color. The experimentors refer to these reactions all together as nervous excitation and conclude that feeling responses to color are due to association of color with object, design, and situation rather than to any inherent feeling-response to color itself.

In the experiment by Pressey[45] mentioned above, color had no differential effect on pulse and respiration. However, Lovett[46] found that capillary blood-oxygen saturation was affected by different colors. He exposed a colored card for five seconds to each of forty-eight healthy and thirty-eight psychiatric subjects and then took an oximetric reading to determine the subject's capillary blood-oxygen saturation. Within the normal group, anoxaemia was increasingly evident, in order for: blue, green, orange, yellow, purple, and red. In other words, blue was the least stressful. Among the psychiatric group, however, where there was diminished oximetric lability, color was less influential.

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[44] Pierce and Weinland, Personnel Journal, XIII, 34-38.

[45] Pressey, American Journal of Psychology, XXXII, 326-356.

[46] Lovett and Schneider, Journal of Clinical Psychology, XI, 366-370.

In the preceding chapter it was seen that, in the popular literature, many and varied emotional effects are attributed to colors. In this chapter, it was seen that very little psychological research has been done concerning emotional effects of colors. Three studies involving only matching colors with verbal descriptions of emotions achieved results in agreement with popular opinion. In the two experiments which involved amount of work output in the presence of color, results were contradictory. In the two experiments concerning physiological factors, one experimenter concluded that color had no differential effect on pulse or respiration, but the other experimenter found that color differentially affected the subjects' capillary blood-oxygen saturation. It was concluded in the experiment involving report of introspective feelings that, although these feelings or reactions were pronounced, there was no response characteristic of any color. Thus, there is no basis in research for the broad, dogmatic statements in the popular literature concerning effects of colors on human emotions. However, considering the contradictory results of the research, these statements cannot be absolutely refuted either.

III. PURPOSE OF THE PRESENT STUDY

That certain colors consistently arouse certain emotions is agreed upon by many popular writers. This alleged property of color is more strongly and more frequently stressed than any other. The possibility of the existence of differential effects of colors upon emotions has been the topic of very little psychological research, however; and a compilation of the few studies undertaken reveals rather contradictory conclusions.

Thus, the purpose of this experiment was to attempt to determine whether there are differential effects of colors upon emotions. The subjects were not aware that the colors present were part of the experiment so that their responses would not be influenced by this knowledge. Since it is conceivable that, due to specific learning, certain colors may initiate emotional reactions if coupled with certain situations or objects (as in purple milk, for example), an attempt was made to employ "abstract" color. Also, since persons normally encounter color in the form of pigment rather than illumination, pigment was employed as the source of color stimulation.

IV. APPARATUS AND MATERIALS

The experiment was conducted in a room divided into cubicles (5' x 7') by light gray cinderblock walls. In each of ten such cubicles was a straight chair and a table, whose surface measured 30" x 40". A sheet of lightweight cardboard covered each table, and, at the opposite end of the table from the chair, another sheet was supported perpendicular to the table and parallel to the back wall of the cubicle. Two cubicles contained yellow paper; two, green; two, red; two blue; and two control cubicles, gray. Two additional cubicles, the pretest cubicles, were each equipped with five chairs and a table covered with the gray cardboard. An attempt was made to equate the chromatic stimuli as nearly as possible with respect to brightness (middle) and saturation (full) and to choose a gray of brightness comparable to that of the colors. According to the standard Munsell[47] color system, the stimuli used were approximately as follows: 5 Y 8/10; 5 G 5/8; 5 R 4/10; 5 B 5/6; and Gray 7/ .

Figure 1 shows the sheet of directions for the questionnaire, and Figure 2 shows the questionnaire itself, as developed for use in this study. The questionnaire contains fifteen linear scales, each scale ranging from the extreme of one emotion (e.g., "interested") through neutral, to the extreme of the opposite emotion (e.g., "bored"). Each of the sixty-one dots in the line composing a scale represents a different degree of emotion. Only four of the scales (energetic-listless,

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[47] A. H. Munsell, Atlas of the Munsell Color System.

cheerful-depressed, relaxed-excited, and meditative-active) were scored. The remaining eleven scales were included to (1) lengthen the questionnaire, in order to expose the subject to color for a considerable length of time, and (2) to increase the "face validity" of the test.

For a physiological index of emotionality, excitability, or tension, a measure of palmar sweating was taken.[48] Mimeograph paper was soaked for three minutes in a five per cent solution of tannic acid prepared in distilled water. There was also prepared a solution of thirteen grams of anhydrous ferric chloride, four hundred cubic centimeters of pure acetone, and three drops of hydrochloric acid. In use, a small amount of the latter solution is applied to the subject's finger and allowed to dry; when the finger is then placed with firm pressure on the impregnated paper, any perspiration present carries the ferric chloride into solution with the tannic acid, making a fingerprint of ink on the paper.

The intensity of the perspiration prints was measured with a densitometer. This densitometer consisted of (1) a Weston Foot-Candle Meter, Model 614, whose sensitive surface was covered with a metal diaphragm in which was cut an aperture one-half inch square, (2) a light-source, which was simply a thirty-five millimeter film strip projector mounted on a metal frame in such a way that its beam of light projected downward onto the foot-candle meter, and (3) a General Radio "Variac," which permitted control of the intensity of the light-source.

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[48] For the theory and justification of this method, see: O.M. Mowrer, B. H. Light, Z. Luria, and M. P. Zeleny, "Tension Changes during Psychotherapy, with Special Reference to Resistance." Psychotherapy: Therapy and Research, pp. 591-600, 626-640. Edited by O. H. Mowrer.

MAJOR_____ CLASS_____

On the questionnaire there are 15 lines. Each line represents the range from the extreme of one mood through neutral to the extreme of the opposite mood.

For example:

very interested	somewhat interested	neutral	somewhat bored	very bored

You are to make an X through the dot that is at the position that best represents how you feel at the moment you are marking it.

For example:

very interested	somewhat interested	neutral	somewhat bored	very bored

Please try to be as objective as possible. In other words, stop and think about each statement and express how you feel at that moment, so that you will not be in danger of being influenced by any preconceived ideas of yourself or stereotyped views of your major or class.

FIG. 1. DIRECTIONS TO QUESTIONNAIRE .

AT THIS MOMENT I FEEL:

very happy	somewhat happy	neutral	somewhat sad	very sad
very pessimistic	somewhat pessimistic	neutral	somewhat optimistic	very optimistic
very critical	somewhat critical	neutral	somewhat tolerant	very tolerant
very energetic	somewhat energetic	neutral	somewhat listless	very listless
very hostile	somewhat hostile	neutral	somewhat friendly	very friendly
very cheerful	somewhat cheerful	neutral	somewhat depressed	very depressed
very afraid	somewhat afraid	neutral	somewhat confident	very confident
very joyful	somewhat joyful	neutral	somewhat sorrowful	very sorrowful
very relaxed	somewhat relaxed	neutral	somewhat excited	very excited

Fig. 2 QUESTIONNAIRE
(cont. on page 18)

very complacent	somewhat complacent	neutral	somewhat anxious	very anxious
very disgusted	somewhat disgusted	neutral	somewhat pleased	very pleased
very meditative	somewhat meditative	neutral	somewhat active	very active
very worried	somewhat worried	neutral	somewhat carefree	very carefree
very peaceful	somewhat peaceful	neutral	somewhat restless	very restless
very secure	somewhat secure	neutral	somewhat insecure	very insecure

Fig. 2 QUESTIONNAIRE

V. PROCEDURE

Ninety subjects were randomly chosen from the Woman's College student body and then randomly assigned to nine groups of ten subjects. Since each color was represented twice in each of the groups (there being two cubicles of the ten for each color), each of the colors was represented by 18 subjects.

For a period of one week, the groups were tested during the evenings. The subjects were told that the experiment concerned the effect upon emotions of one's major subject and class year in college.

When the subjects were brought to the laboratory, they were asked by the experimenter to enter either of the two pre-test cubicles they wished and to be seated in any one of the five chairs they chose. Thus in each pre-test cubicle there were five persons seated around a table covered with gray paper. The experimenter, in one, and an assistant, in the other, coated the middle finger of the right hand of each subject with the ferric chloride solution. After the solution had dried, the subjects placed their fingers with firm pressure, as demonstrated by the experimenter, upon the impregnated paper for three minutes. Since different persons have different levels of palmar sweating due to other factors besides the presence of colors, this measure was taken in order to have an index of each subject's palmar sweating in an achromatic situation.

On each of ten sheets of directions to the questionnaire was the designational number of one of the ten test cubicles. These sheets,

which had previously been put in an arbitrary order by reference to a table of random numbers, were passed around the table in a predetermined order, in which the subject in the first chair received the top sheet and the subject in the last chair received the bottom sheet; subjects were thus assigned to cubicles (and colors) at random. After each subject had specified her major and her class in the appropriate spaces and had transferred the cubicle number onto the fingerprint sheet, the experimenter read the directions through with the subjects and answered any questions.

Then each subject proceeded to the cubicle designated by the number on her direction sheet. In each cubicle the subject found a questionnaire and a pencil. After filling out the questionnaire, the subject summoned the experimenter to her cubicle. There, following the same procedure used the first time, another fingerprint was made on the same sheet of impregnated paper, with the subject in the presence of the colored paper.

Each of the four critical scales on the questionnaire was scored by counting the number of dots from the left-hand end of the scale through the dot marked with the "X". Thus, the highest possible score represented the most intense experience of the emotion on the right end of the scale.

The intensity of each fingerprint was measured by placing the clear portion of the paper on which it appeared over the aperture in the diaphragm of the foot-candle meter and adjusting the illumination by means of the Variac to give an arbitrary twenty-five unit reading on the meter. Then the first fingerprint was placed over the aperture, and the meter reading was recorded. This reading could be anywhere

between zero and twenty-five. Then the reading for the second fingerprint was recorded in the same manner. After the three readings had been re-checked, the difference between the two critical readings was derived. This latter figure, an index of the extent to which perspiration was enhanced by the presence of color, was used in the statistical computations.

VI. RESULTS AND DISCUSSION

An analysis of variance was performed upon the data from each of the four critical scales (energetic-listless, cheerful-depressed, relaxed-excited, and meditative-active) and upon the data from the fingerprints. The results, shown in Table 1, were not in any instance significant at even the .05 level of significance. In fact, the F-ratios for the four scales were all less than 1.0. In other words, there was more difference among the subjects in the presence of any one color than there was among the several groups in the presence of different colors. For the fingerprint data, the F-ratio is above 1.0, but still, of course, short of significance. Edwards'[49] short test for homogeneity of variance was performed in conjunction with each F-ratio (Table 2); only the fingerprint data showed any signs of significant heterogeneity; the F-ratio for this data, already insignificant, may thus, even so, be slightly inflated.

Thus, it is concluded that, at least among white, American, female, college students, abstract colors neither increase nor decrease to a significant degree the general level of emotionality, at least as manifested in palmar perspiration, and that they almost definitely do not arouse certain specific emotions as reported introspectively by the subject.

Several points of procedure should be justified when evaluating the results. The first concerns the use of the fingerprinting technique:

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[49] A. L. Edwards, Statistical Methods for the Behavioral Sciences, pp. 327-328.

INDEX OF EMOTION		MEAN SQUARES	DEGREES OF FREEDOM	F-RATIO
I. Energetic-Listless	between groups	302	4	.94
	within groups	322	17	
II. Cheerful-Depressed	between groups	134	4	.44
	within groups	302	17	
III. Relaxed-Excited	between groups	164	4	.55
	within groups	297	17	
IV. Meditative-Active	between groups	154	4	.60
	within groups	255	17	
V. Palmar Perspiration	between groups	84.0	4	1.50
	within groups	55.9	17	

F-ratio must be at least 2.49 to be significant at the .05 level of confidence.

Table 1. DATA: F-RATIOS

INDEX OF EMOTION	VARIANCE RATIO
I. Energetic-Listless	1.55
II. Cheerful-Depressed	2.14
III. Relaxed-Excited	1.56
IV. Meditative-Active	1.32
V. Palmar Perspiration	3.15*

*VARIANCE RATIO OF 2.27 IS SIGNIFICANT AT THE .05 LEVEL.

Table 2. RATIOS FOR HOMOGENEITY OF VARIANCE

Mowrer[50] suggests that postal scales be used to equate the amount of pressure exerted by the subjects while taking the prints. Instead of employing scales, however, the experimenter demonstrated to all the subjects the firm pressure required and instructed them to use just the same amount of pressure for the second print. After checking in preliminary trials before the experiment, the experimenter was satisfied that this procedure was adequate.

Since completing the fifteen-scale questionnaire required only about five to ten minutes, the subject had been in the presence of the color only a short time when she marked the critical scales. When planning the procedure, the experimenter decided that if color really had pronounced and universal emotional effects, these effects should manifest themselves soon after the subject was exposed to the color. The fact that the highest F-ratio was obtained from the fingerprints, which were taken after the questionnaire had been marked, tends to create the suspicion that the subject was not in the presence of the color long enough. Since the highest F-ratio for the four scales was obtained from the first scale, however, the above rationalization is greatly weakened. In any case, furthermore, it is difficult to compare F-ratios, all of which are insignificant.

It is recognized that palmar perspiration may not be a wholly adequate index of the complex "system" of emotions. It would be impractical and almost impossible to measure all of the accepted physiological manifestations of emotion. Thus, since palmar

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[50] Mowrer, op. cit. pp. 591-600, 626-640.

perspiration seems to be as adequate and reliable as any other one measure employed alone, it was chosen because of its simplicity of application.

It would have been better had there been more subjects. Any slight differential effect of color which might exist would be more likely to manifest itself when there are many subjects to insure that no extraneous force is affecting most of the subjects. Eighteen subjects per color-group is, however, a respectable number, and the negative results obtained would thus seem to be of some practical importance.

VII. SUMMARY

In an investigation of the popularly reputed differential effects of colors upon emotions, an introspective report of emotion, and a physiological measure of emotion, both completed while in the presence of color, were submitted by each of ninety subjects. Analyses of variance on these data produced negative results. Therefore, abstract color seems to have no universal differential effect upon emotions.

These results, which are in agreement with the introspective data reported by Pierce and Weinland[51] and with the data concerning pulse and respiration reported by Pressey,[52] contradict the results of the psychological studies in which colors and verbal descriptions of emotions were paired and the usual statements in popular literature.

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[51] Pierce and Weinland, Personnel Journal, XIII, 34-38.

[52] Pressey, American Journal of Psychology, XXXII, 326-356.

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